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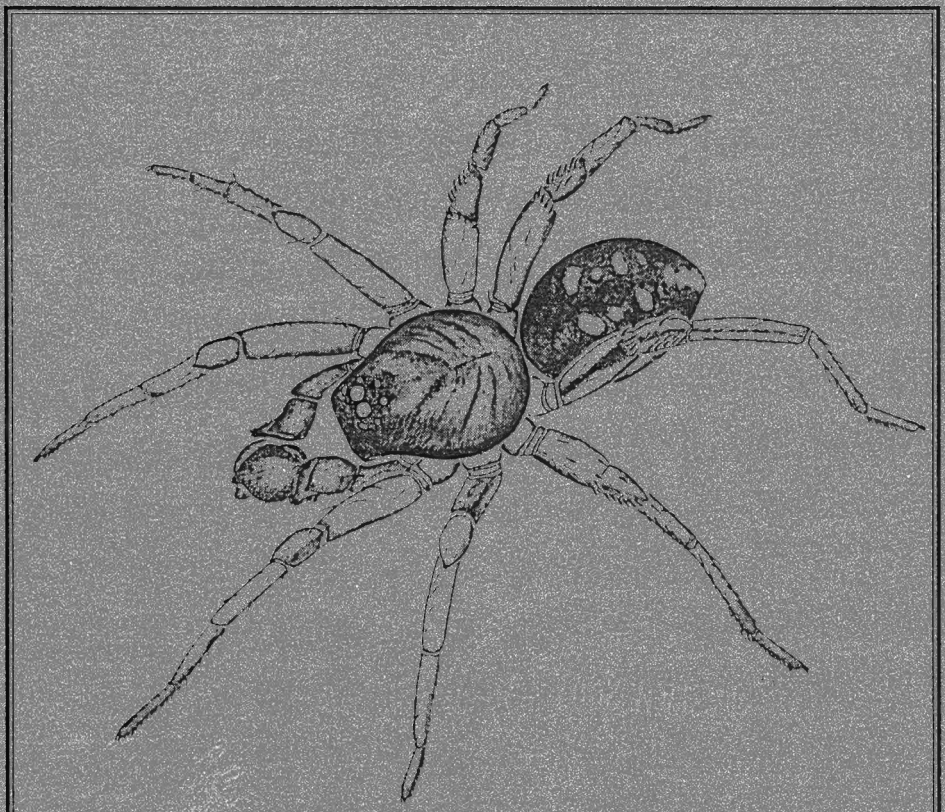

E.N. MARKS MEMORIAL ISSUE

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ENTOMOLOGICAL SOCIETY OF QUEENSLAND

Membership is open to anyone interested in Entomology. Meetings are normally held in the Department of Zoology and Entomology, University of Queensland on the second Monday of March-June and August-December each year. Meetings are announced in the Society's News Bulletin which also contains reports of meetings, entomological notes, notices of other Society events and information on Members' activities.

Enquiries relating to the Society should be directed to the Honorary Secretary, Entomological Society of Queensland, P.O. Box 537, Indooroopilly, Qld. Australia, 4068.

Cover: This undescribed ant spider (Zodariidae), known only from the Expedition Range, is one of about 25 new *Habronestes* species from Queensland. In Australia, *Habronestes* is one of the most diverse genera of ant spiders with almost 130 species, of which only about one fifth are described. They are small to medium-sized spiders (2 – 12 mm in length) and most can be recognised by the bright yellow or orange spots on their backs and the distinctive palps of the males. Illustration by Barbara Baehr.

THE AUSTRALIAN ENTOMOLOGIST
E.N. MARKS MEMORIAL ISSUE

Dr Elizabeth Nesta ('Pat') Marks AO
BSc (Qld), MSc (Qld), PhD (Cantab.), FRES
28 April 1918 - 25 October 2002

Publication of this symposium is partly supported by a grant from the Australian Entomological Society.

To honour the life of E.N. Marks, the Entomological Society of Queensland held a symposium at the Queensland Museum on October 15, 2005, chaired by Society President, Peter Mackey. This special issue is devoted to the proceedings of that meeting. The speakers, pictured above from left to right, were as follows:

Joan Bryan was supervised by Pat Marks for Honours in the 1960s. She worked first in Papua New Guinea, then with the London School of Hygiene and Tropical Medicine. She came to the Sydney School of Public Health and Tropical Medicine in 1982, then spent her last 17 working years at the University of Queensland (UQ). **Geoff Monteith** is a curator of insects at the Queensland Museum and formerly curator of the UQ Insect Collection. He occupied a room across the corridor from Pat for a decade during her UQ days and was drawn into many of her 'extra-curricular' activities. **Brian Kay** has worked with mosquitoes as disease vectors at the Queensland Institute of Medical Research since 1963 and shared office space with Pat in QIMR's second building behind the Royal Brisbane Hospital. **Brian Crozier** is a history curator at the Queensland Museum and is responsible for the Social History collection. Brian negotiated the final wave of donations from the Marks family in 2002. **Margaret Ward**'s mother was Pat's cousin, and Pat was a major influence in Margaret's life from early childhood. In turn, Margaret became Pat's greatest support in her last years and was present (and taking instructions) when she died in 2002. **Harry Standfast** worked on malaria in Papua New Guinea from 1956-1962, then joined QIMR in Brisbane to study both mosquitoes and biting midges as virus vectors. In 1970 he moved to CSIRO Division of Animal Health, retiring in 1990. He interacted closely with Pat throughout his professional life. **Mike Muller** studied insect-borne diseases in livestock with CSIRO for 23 years before becoming the Brisbane City Council's medical entomologist 10 years ago. In both lives, Pat Marks' mosquito keys and taxonomic papers have been constantly beside his microscope. **Peter Mackey**, President of the Entomological Society of Queensland and Chairman of the Symposium. **Margaret Schneider** and her co-author **Greg Daniels** (absent) are former and present curators of the UQ Insect Collection. They collaborated closely with Pat during the difficult incorporation of her mosquitoes into that collection.

ELIZABETH NESTA MARKS – THE FAMILY MEMBER

MARGARET WARD

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Abstract

An insight into the family life and legacy of Elizabeth Nesta (Pat) Marks is presented.

Introduction

Elizabeth Nesta Marks was born in Dublin on 28 April 1918. Her Australian-born parents were in Ireland while her father completed his medical studies at Trinity College, Dublin and subsequently served in the British Army during the First World War. She was baptised in St Patrick's Cathedral, Dublin where her great-great-grandfather had been a canon. From thence, she was nicknamed 'Patricia' by her extended family. While her mother and father valiantly tried to maintain her given name, other branches of the family had different ideas and she became Patricia (or Pat) to all who knew and loved her.

Family life

Patricia was my mother's cousin. She was an only child of two independent-thinking, intelligent and inquiring people. They were a household of 'different characters' who often clashed but loved and admired each other. Their common love was for the outdoors and the conservation of the environment.

For over 60 years Patricia lived at 101 Wickham Terrace, in the medical heart of Brisbane and only a short walk from the city centre. Patricia's family was part of a larger commune of Marks and Dods relations who lived and worked in residences at 97, 101 and 107 Wickham Terrace. These properties extended through to Astor Terrace. It was here that Patricia learnt the importance of family, including her ancestors and those not yet born.

The Marks family's weekend retreat was a large bush property at Camp Mountain, near the village of Samford, just beyond the northwest outskirts of Brisbane. Their residence was a derelict workers' barracks from a nearby granite quarry which the family and friends had relocated and refurbished in 1942 (Marks and Cummins 2004). There was room to run some horses and riding was a popular family pastime.

Patricia became an excellent student (Fig. 1) (dux of her high school in 1934), swimmer, hockey player and horsewoman (Fig. 2). She received a 'blue' for her swimming and a half blue for hockey from the University of Queensland. This was to the amazement of the Marks family who preferred a less competitive lifestyle. However, her family genes came through with her love of poetry and books, her inquisitive nature and commitment to her family and friends.

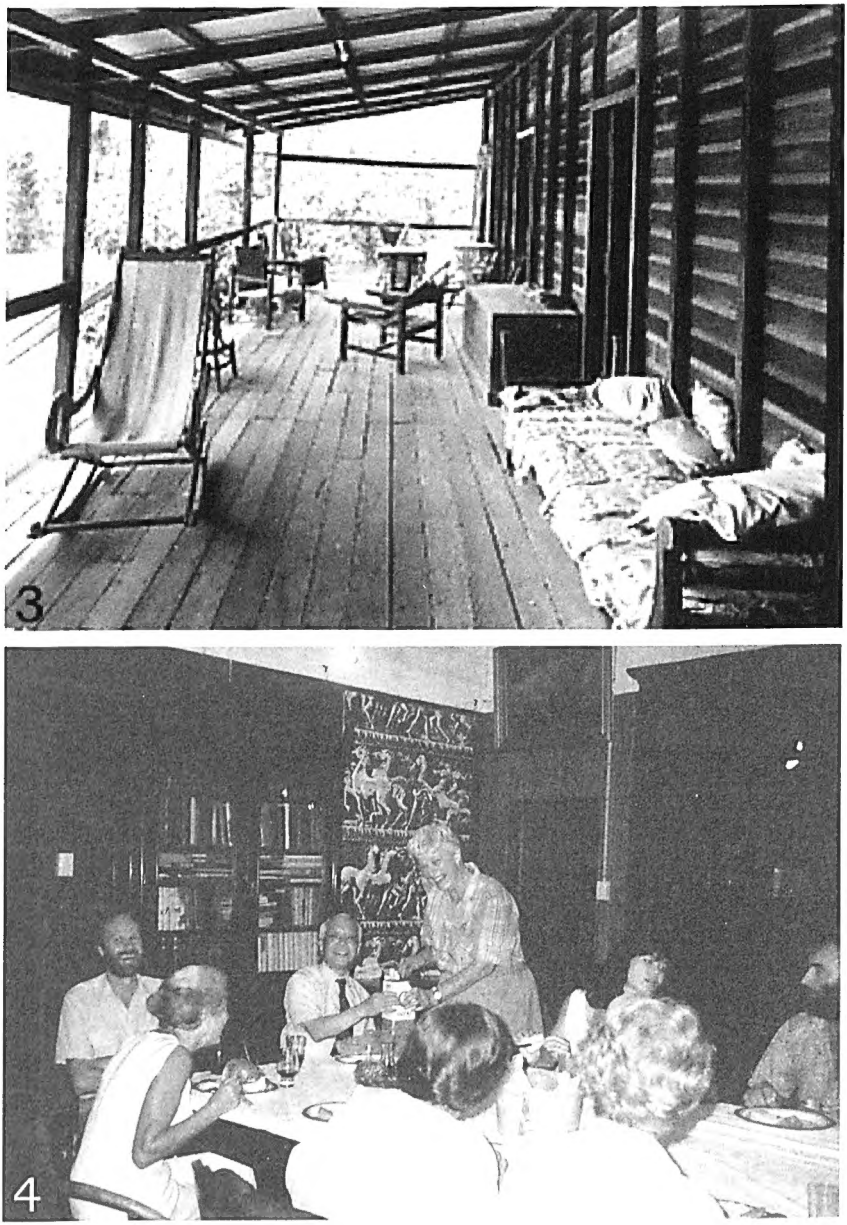
Figs 1-2. (1) Pat Marks at her BSc graduation from the University of Queensland in 1938. (2) Pat riding 'Taffy' in the flag race at Samford Sports Day, 1938.

What I can offer here is a personal picture of Patricia Marks, a woman who was generous, formidable, inquisitive, rigorous in her work and a defender of family history and tradition.

Her family and their history were very important to Patricia. She became the caretaker for the vast collection of furniture, jewellery, curios and household items collected by her ancestors. Most of the historical items are now in museums and libraries (see Crozier 2006). However, many were kept by the family and, as was the tradition, they acquired names and perhaps personalities as well, such as Miss Johnson (a glass fronted cupboard), the Reverend Edward (a tall bookcase) and Mrs Bird (a clock).

Not often at ease with people, Patricia had a gruff manner which deterred the faint-hearted. Those who persisted discovered a woman keen to offer her knowledge, time and money for a worthy cause. Patricia supported a wide range of organisations, promptly paying her annual dues and thoroughly studying their material. 'I have been a treasurer' she once said, 'I know how nice it is to receive my cheque!'

Patricia's mind was always working. This was to the detriment of her day-to-day housekeeping and general tidiness. Her large living room was scattered with projects, historical investigations, critiques of a younger scientist's work, an obituary for a fellow colleague. It seemed like chaos to me. However, Patricia knew where everything was and admonished me if I tried to tidy or throw out. She spotted whenever I made a mistake or dared to intervene.



Figs 3-4. (3) Verandah of the Marks family retreat at the Samford property, destined to become an environmental education centre. (4) Pat Marks hosting a Sunday lunch for visiting Japanese Professor Seiroku Sakai at the Samford property.

To our relief, Patricia mellowed with age. Always passionate about her horses and an experienced horsewoman, she continued riding until she was eighty, using her younger relatives to saddle the horses, open the gates, and help her dismount. She gave increasing amounts of time and energy to the Samford community, the local museum and the aboriginal reconciliation group.

Her 84th birthday was celebrated at Samford. My brother surprised her by organising Patricia's grandfather's car, presently in the RACQ museum, to be brought out for joy rides on the day. She was thrilled! She climbed in and whizzed around the paddock with gay abandon.

Preferring her own company, she lived simply on her cherished Samford property for the last 20 years of her life. A goanna has been known to walk casually through her bedroom, a large python digest the in-house possum on top of the bookcase and the bush turkeys and butcher birds demand attention at the kitchen door. Her horses were 'her children'. She called them with a distinctive voice which I have since had to emulate to gain their attention.

At this peaceful haven, Patricia welcomed international scientists, students, family, neighbours and friends (Figs 3-4). Once you made your presence known, you were free to peruse her many books, wander the bush or even snooze the day away. This was where she taught us to ride, to be inquisitive about the nature of things and to hear the family history. It is here the family stood in a circle and spread her ashes when she died.

As part of her legacy, Patricia dedicated her property for ecological use and as a memorial to the Marks family. My brother and I, as executors, are presently working with a number of prospective beneficiaries to develop it for the study of ecological issues.

In the 1930s, whilst at the Glennie Memorial School, Patricia wrote to Bishop Donaldson requesting a motto for the dedication of the Donaldson Wing of that school. The motto, when received, was: 'Whatsoever thy hand findeth to do, do it with all thy might.' It is a motto that Pat personally adopted and lived to the fullest.

I thank all those who came to honour our beloved cousin and to hear of her legacy to entomology and the Museum.

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ELIZABETH NESTA MARKS – HER OTHER LIFE AS SOCIETY ACTIVIST, CONSERVATIONIST, HISTORIAN AND BIOGRAPHER

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Abstract

Details are provided on the role of Elizabeth Nesta Marks as Society leader and activist, as conservationist, and as historian/biographer.

Introduction

The distinguished Australian entomologist, Elizabeth Nesta ('Pat') Marks (1918-2002) is best known for her long career as a mosquito taxonomist and resident Australian expert on all things mosquito (Marks and Cummins 2004, Anon. 1986). She was a woman of imposing presence and strong personality, with a sense of obligation to her science and to the community in a broader context. She became involved in many issues and it is fair to say that some of these consumed her time at the expense of her mosquito work, often to her own frustration. But Australian science benefited greatly from those competing interests. The purpose of this paper is to highlight some of these 'extra-curricular' passions of Pat Marks.

Society leader and activist

Today, as most scientific societies struggle to compete with television, the internet and commercialized sport to get members along to meetings, it is difficult to conceive how important these groups were in the 1950s-1960s when Pat Marks was at the height of her scientific activity. She was then based in the Entomology Department at the University of Queensland, a period she later said was her most contented and productive. Fig. 1 shows the staff and postgraduates of the Department in 1964. Almost everyone in that photograph would have turned up to the regular 'second Monday of the month' meetings of the Entomological Society of Queensland, where they would have mixed with perhaps 30 or 40 other entomologists, from every institution in Brisbane which harboured a glint of six-legged science within its walls. On the 'third Monday of the month' there was the meeting of the Queensland Naturalists' Club, where field-inclined professional biologists mingled with a great slew of keen amateur biologists, often 60-80 attending. The 'first Monday of the month' was the Royal Society of Queensland's night, when an eclectic mix of Brisbane scientists, ranging from geologists and botanists to mathematicians and biochemists, filled a lecture hall to hear a guest speaker, often a visiting international scientist. The Royal Historical Society of Queensland also had its night. A feature of almost every one of these Brisbane meetings for almost 50 years was the presence of Pat Marks, usually sitting front row centre, and a participant in everything that went on.

Figs 1-2. (1) Staff and postgraduates of the Entomology Department, University of Queensland in 1964. L to R, back row: Geoff Monteith, Rajainder Kumar, Ian Yeo, Tom Woodward; main row: Christine Buckley, Ann May, Sybil Curtis, Elizabeth Bernays, Angus Macqueen, Margaret Colledge, Lesley Powell, Pat Marks, Athol Perkins; kneeling: Elizabeth Exley, Patricia Webb. (2) Three distinguished Honorary Members of the Australian Entomological Society (L to R): John Evans, Pat Marks and Ian Mackerras, photographed at Tom Woodward's home in 1978.

Pat had been inculcated into the milieu of scientific societies through her father, E.O. Marks, medical doctor, geologist, inventor and leading Brisbane intellectual. She inherited a strong feeling about the importance of these groups to scientific life and later wrote: 'no Society has the right to the designation 'scientific' if it exists only to serve its members - its prime duty is to the discipline it represents and the community it serves (Marks and Mackerras 1971). In other words, she thought these groups should not just run 'feel-good' meetings and outings, they should also do the 'hard yards' to promote their science and tackle the issues of the day. This she herself did with a vengeance throughout her career, serving on councils of numerous societies (Table 1), becoming President of four and gaining the ultimate accolade, Honorary Life Membership, of five of them.

She was resolutely committed to truth, fairness, transparency and scientific integrity in all her society activities and did much good. Being an active member of many societies she was the conduit for much 'cross-pollination' of ideas and activities between societies. Those of us with long memories know she was also a vehement stickler for procedural correctness, and woe betide the new secretary who didn't record the motion seconder correctly, or the treasurer who couldn't explain the minutiae of his accounts. Her reputation and experience led to her playing a central role in some society-based issues, such as:

Formation of the Australian Entomological Society

One of the major issues which Pat became involved in was the formation, in 1965, of the Australian Entomological Society, our first and only national entomological group. One would think that this would have been a welcomed move, but in fact it was almost prevented by bitter jealousies between State-based groups - nothing new there - but it was largely Pat's steely resolve to find middle ground between the factions that saved the day. When the Entomological Society of Queensland was formed in 1923, one of its stated constitutional aims was the formation of a national entomological society. In 1953, it canvassed entomologists and found support and, in 1962, started the *Journal of the Entomological Society of Queensland*, with the express object of transferring it to a new Society to be named the Entomological Society of Australia. To the astonishment of Queenslanders, a group in Sydney called the 'Society of Entomologists' promptly changed its name to the 'Entomological Society of Australia (NSW)' and started a journal called the *Journal of the Entomological Society of Australia* (*NSW*), thus preoccupying the name intended for the planned new society and its journal. This created enormous consternation, because years of efforts by ESQ, CSIRO Entomology and many individuals had gone towards paving the way for the new society. Eventually, it was Pat Marks who journeyed south to meet with the recalcitrant group and, by sheer force of logical argument, stared them down and gained their agreement to allow the new society and its journal to

proceed as planned. Pat Marks was first Chairman of the Executive, later President and Honorary Member, of the new national society named, by force of circumstance, the Australian Entomological Society. Its formation received the overwhelming support of Australian entomologists and was a great source of pride to Pat Marks for the rest of her life. Characteristically, Pat eventually documented the controversy of its formation in detail for the historic record (Marks and Mackerras 1971).

Table 1. List of societies of which Pat Marks was a member, showing offices in which she served.

Society, period of membership and offices held (in chronological sequence)
Queensland Naturalists' Club: Member 1937–2002. Offices held: Treasurer, Councillor, Editor, Excursion Secretary, Vice President, President. Honorary Life Member 1976.
Royal Society of Queensland: Member 1939–2002. Offices held: Councillor, Treasurer, Vice President, President. Life Member.
Entomological Society of Queensland: Member 1944–2002. Offices held: Councillor, Secretary, Vice President, President. Honorary Life Member 1987.
National Parks Association of Queensland: Member 1945–2002.
Linnean Society of New South Wales: Member 1948–2002.
Royal Entomological Society of London: Fellow 1951–2002.
Royal Historical Society of Queensland: Member 1955–2002.
Australian and New Zealand Association for the Advancement of Science: Member 1960-2002.
Samford Bora Grounds Preservation Committee: Member 1963–1967.
Australian Entomological Society: Member 1965–2002. Offices held: Councillor, Editorial Board, Convener of Conservation Committee, Vice President, President. Honorary Member 1972.
National Trust of Queensland: Member 1966–2002.
Australian Conservation Foundation: Foundation Member 1966–2002. Offices held: Councillor, Member of Executive Committee, Chairman of Northeast Regional Committee.
Royal Zoological Society of New South Wales: Member 1968–2002.
Pine Rivers Historical Society of Queensland: Member 1971–2002.
Museum Society of Queensland: Member 1971–2002.
Mosquito Control Association of Australia: Member 1990–2002. Life Member 2000.

The 'Regulation 13A' Controversy

In the science of insect taxonomy, specimens are our currency. Many thousands of specimens move through the international mail as taxonomists borrow and lend them for study. Of those specimens, holotypes are of supreme importance. Most taxonomists would agree that it is desirable that holotypes be lodged, where appropriate museums are available, near to their geographic origin, but this is not essential and many factors may influence a particular situation. In July 1973, a new Regulation 13A was added to the Australian Federal Customs Act 1901-1971, which sought to make it mandatory for new Australian insect holotypes to be lodged in Australian institutions. This appeared without consultation with the entomological community and brought in a situation where it became very difficult for workers outside the major museums to continue to exchange specimens. It also severely limited the ability of overseas museums to acquire Australian insects unless they lodged a permanently binding 'holotype declaration' with the Australian government, which many were not prepared to do. As these implications of the new Regulation sunk in, a giant protest swept scientific circles in Australia and overseas. However, its proponents, who were in positions of considerable power, refused to budge. Pat Marks, with her clear mind and her commitment to international cooperation, quickly emerged as a fearless leader of the opposition. Soon after, she began her term as President of the Australian Entomological Society and, in that capacity, she was able to survey entomologists to demonstrate the overwhelming opposition. She personally confronted politicians and senior bureaucrats in their dens. She got numerous other organisations onside, including the Australian Academy of Science. The matter dragged on for almost a decade and she bitterly resented the inroads it made into her mosquito work, but she worked because there was a high principle involved. Frustratingly, there was never a clear victory, but the Regulation eventually simply disappeared from the statute books because of its inherent unworkability. In true Marksian manner she recorded the whole matter, blow by blow, for posterity (Marks 1978).

Pat Marks as Conservationist

Nature conservation, as a popular concept, really only swam into widespread consciousness in the 1960s. A landmark was the formation of the Australian Conservation Foundation in 1966, an event which gained impetus from the publication of Jock Marshall's seminal book *The Great Extermination* (Marshall 1966) in the same year, shortly before the author's premature death. Pat Marks was a foundation member, an inaugural councillor and, within a year, chairman of the ACF Northeast Regional Committee.

Jacaranda Press, a prominent nature publisher in Brisbane, proposed a book by Australia's leading conservationists to be dedicated to Jock Marshall's memory and with royalties going to ACF. A stable of stellar authors was arranged, including Judith Wright, Len Webb, Vincent Serventy, Jeff

Moseley, Max Day, Dick Piesse and other luminaries of the day. Pat felt the invertebrates should be covered, an unheard of idea at that time, but was reluctant to do the job herself because her specialty was mosquitoes, a group not likely to enthuse the public about invertebrate protection. In the end the task fell to her and she produced a masterly chapter by collating information from her vast network of contacts. It stands as the first attempt to argue a general case for invertebrate conservation in Australia, even though, as she wrote: 'invertebrate zoologists ... need to be stirred out of their defeatist attitude [or] no one will be interested' (Marks 1969). The book itself was one of the first large format, 'coffee table'-type books on Australian nature, complete with foreword by HRH Prince Philip, and is a milestone in our conservation annals.

Later she was Inaugural Convenor of the Australian Entomological Society's Conservation Committee and undertook the extremely onerous task of preparing a submission to the 1972 Senate Committee on National Parks and Wildlife.

On the local scene, Pat worked hard for the preservation of an aboriginal bora ground near the family property at Samford, establishing a Committee, through the Queensland Naturalists' Club, which eventually achieved permanent protection for the site (Marks 1968). With typical thoroughness, as part of that process Pat researched and compiled a review of 58 known aboriginal ceremonial grounds in southeast Queensland.

Pat Marks as Historian/Biographer

Pat Marks was an avid historian, a habit ingrained within her family where an intense pride and interest in their family heritage was shared by all. Like all historians, she had a reluctance to throw things away and the shelves of her famously untidy room sagged under bulging, brown leatherboard boxes of papers, labelled with scribbled subjects on their ends. Amazingly, she could usually put her hands on the particular item of the moment.

She felt she had a duty to record her historical researches for posterity. Determined to get to the truth of matters, she was always careful to record both sides of contentious issues. There are two main themes to her historical writings. Firstly, recording the events and personalities surrounding the formation of scientific societies in Australia and, secondly, biographies (often as obituaries) of individuals, mostly scientists. The best source of references to these is Pat's entry in the recent comprehensive bibliography of Australian entomology by Daniels (2004), while many non-entomological items can be found in the anonymous (but almost certainly self-written) biography that accompanies Pat's Belkin Medal nomination (Anon. 1986).

In writing biographies, Pat always said she tried to get inside her subject, to be able to see the world through their eyes. Reading her accounts, one often comes away with the feeling that you knew how the person looked and

spoke. The entomologists she documented were often passionate people and she always tried to find what had initially set them on their path. Her master work, and swan song, is the 22 page 'Biographical history' chapter in the 1991edition of *Insects of Australia* (Marks 1991), in which she weaves scores of characters into the two hundred year history of Australian entomology, with each individual clearly defined. Characteristically, one of the major players, herself, rates hardly a mention.

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Elizabeth ('Pat') Marks sitting in an ancient theatre during the International Congress of Entomology in Greece.

DR ELIZABETH N. MARKS AO: MOSQUITO STUDIES 1940–1976

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Abstract

The early scientific life of Dr Elizabeth Nesta ('Patricia') Marks is reviewed which, in some small measure, explains why she was such a remarkable person who dominated the Australian mosquito world for an extended period. With her typical thoroughness and her interest in history, Pat collaborated with Kathleen Cummins to produce a comprehensive record of her life in Mosquitoes and Memories – Recollections of 'Patricia' Marks, published in 2004, and required reading for anyone interested in the history of science in Queensland.

Patricia Marks was born into a family with a passionate interest in science, particularly the natural sciences. She grew up surrounded by people who knew the names of plants and animals. Her father, E.O. Marks, was a highly regarded geologist before turning to medicine. It is interesting that, on graduating in 1916, he joined the Royal Army Medical Corps and served in the trenches in France, about one year prior to Ian Mackerras (Fig. 1) who, then a gunner in the A.I.F., was to become one of Patricia's mentors. Ian was gassed at Villers Bretonneux in May 1918. Fortunately for Australian science, his resulting blindness was only temporary.

Fig. 1. Dr E.N. Marks and Dr I.M. Mackerras at the International Congress of Entomology, Canberra 1972.

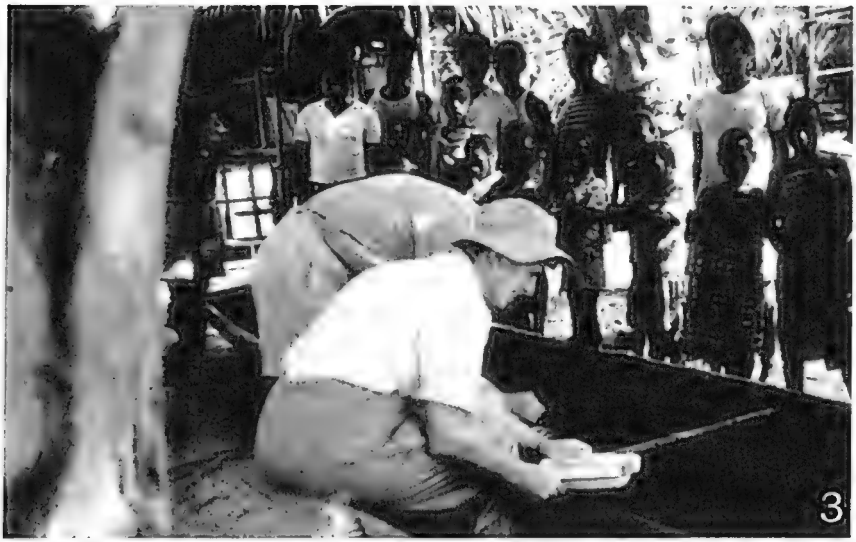
That Pat was an outstanding scientist is not surprising. Her grandfather joined the Royal Society of Queensland in the year it was founded (1854) and became an Honorary Life Member. Her father also became President and an Honorary Life Member of the Society, as did Patricia. While the central thrust of Pat's scientific career was mosquito research, she had a much broader interest in science, stimulated by the number of scientific societies of which she was an active member (Monteith 2006), a habit inherited from her family.

Patricia speculated that her interest in entomology was sparked on a Queensland Naturalists' Club outing in 1927, when she was 9 years old (Marks and Cummins 2004): 'I was fascinated watching him using his net to catch butterflies and other insects and that perhaps started my interest in insects'. The entomologist being watched was Rowland Illidge, a name familiar to mosquito control workers since the endangered *Acrodipsas illidgei* (Waterhouse & Lyell) [Illidge's ant-blue butterfly (family Lycaenidae)], named after him, occurs in mangroves.

One of Patricia's strengths which, I suspect, stemmed from her early training, was the keeping of a diary. This enabled her to produce the detailed accounts which are characteristic of her work. I recently read her 'Diary of Trip to Ingham and Cairns District 1946'. This was one of her early investigations on behalf of the Queensland Department of Health and was a response to a malaria outbreak at Lucinda Point. The account starts on Monday, May 13, when Patricia left Roma Street Station at 8 pm and, 98 closely written pages later, finishes at 8 am on July 12, when she returned to Brisbane. Included is a fascinating account of how an investigation of an outbreak of an insect borne disease should be conducted.

Pat's primary duty with the Mosquito Control Committee (initially as Graduate Research Assistant, later as Senior Research Fellow and finally as Senior Research Officer), until its disbandment, was concerned with research into the taxonomy and biology of mosquitoes of Australia and New Guinea.

In 1939, Pat joined the staff of the University of Queensland medical school, as assistant curator of the pathology museum. She also demonstrated to students in F.A. Perkins' medical entomology course. In 1943, the Queensland Government set up a Mosquito Control Committee: Sir Raphael Cilento, Director General of Health, was chairman, Mr F.A. Perkins, lecturer in entomology, was the secretary, and Miss E.N. Marks was graduate research assistant and its employee. This gave Pat a laboratory to work in at the George Street campus of the University of Queensland (Fig. 2), a salary, and numerous field trips to investigate mosquito problems around the state. This arrangement continued until 1973, when the committee was disbanded. Unfortunately, the grant had never provided for an assistant which would



Figs 2-3. (2) E.N. Marks examining a new mosquito light trap with University of Queensland colleague, Elizabeth Exley, around 1960. (3) E.N. Marks sampling larvae from water in a canoe on the Mamberano River in then Dutch New Guinea in 1958.

have relieved Pat of much of the routine mechanical work and allowed her to concentrate on systematics.

After her appointment in 1943, Pat worked with F.A. Perkins, who was then the officer commanding the Australian Army's Land Headquarters School of Malaria Control. At the time, Allied troop casualties due to malaria in the Pacific outnumbered battle casualties by from 4 to14 times, depending on the theatre. The malaria control workers trained at F.A. Perkins' School played an important part in reducing malaria casualties. A valuable spin-off from this work was interaction with U.S. Army entomologists, both then and in post-war years. These included Willard V. King, Harry Hoogstraal and John Belkin. Belkin's important '*Mosquitoes of the South Pacific*', published in 1962, greatly influenced Pat's work; she was later to be awarded the Belkin Medal, a prestigious award for mosquito workers, in 1986. Pat was also able to interact with the Australian entomologists David Lee and Tony Woodhill.

As the State Health Department's only full time mosquito expert, she was required to investigate suspected outbreaks of mosquito-borne disease and the occurrence of unusual numbers of mosquitoes. These investigations required close liaison with local Councils. Pat rapidly became the first port of call for Local Authorities requiring advice on mosquito control and the identification of species collected. She played a major role in the *Aedes aegypti* (L.) eradication campaign mounted in southeast Queensland in the mid 1950s, which saw the disappearance of both the vector mosquito and the outbreaks of dengue fever frequently recorded in Brisbane.

Pat's official duties saw her traversing Queensland from Torres Strait to the Tweed and from Fraser Island to the Gulf and the Northern Territory. The collections made during National Mosquito Control Committee investigations were supplemented by collections made on Queensland Naturalists' Club outings, all of which resulted in collections of mosquitoes, often giving new locality records and, sometimes, new species. I doubt that any one person has collected mosquitoes from as many localities in Queensland as Pat Marks. In making my own collections in remote areas, I was often told that 'the lady Doctor from the University' had been there several years before me.

It should be noted that, for much of the period between 1940 and 1976 when Pat was working in the north, particularly prior to 1960, the common means of transport was by non air-conditioned rail or by equally uncomfortable motor vehicle. There was no GPS system to tell you where you were plus or minus 4 metres; there were no readily available aerial photographs; there were no radios in vehicles to call for help if you were bogged or if the vehicle broke down; there were no air-conditioned motels and, when they existed, country hotels were primitive by modern standards, so the 'lady Doctor from the University' often had an uncomfortable time in the field.

In later years Pat ran courses in mosquito taxonomy, biology and control for health inspectors, teachers and mosquito control workers in Queensland. This gave her a broad range of collectors spread throughout the state. One notable collaborator was John Wright of Charleville. Her last course was in 1998, at the age of 80. For these courses Pat produced the 'green book', *An Atlas of Common Queensland Mosquitoes* (Marks 1966), familiar to local authority personnel working with mosquitoes, first published in 1966, revised in 1967, 1973 and rewritten for the 1998 course. Pat appreciated that many of the students would not have access to a dissecting microscope and wrote the descriptions emphasising characters which could be seen with a hand lens. Clearly this showed an appreciation of what happened in the field.

Early in 1949 she was granted extended leave and travelled to the United Kingdom, where she completed a PhD at Cambridge in 1951. In the UK she mixed with the greats of the mosquito world - Mattingly, Buxton, Smart, Wigglesworth and Christophers – who must have seen a great potential mosquito worker in this lady from Australia.

Pat resumed duty with the Mosquito Control Committee in Brisbane in late 1951 and was almost immediately sent to Mildura, on the Murray River in Victoria, to participate in an investigation of Murray Valley Encephalitis by a team headed by Dr Bill Reeves, a US expert with experience in working with mosquito-borne viruses. Another member of the team was Dr M. Josephine Mackerras, an outstanding scientist, parasitologist and entomologist, daughter of early Queensland physician and mosquito worker Thomas Lane Bancroft, and wife of Ian Mackerras. Her portrait, as Major Mackerras, hangs in the Australian War Memorial to commemorate her outstanding contribution to the wartime Australian research on malaria.

Although no virus was isolated from the mosquitoes collected at Mildura, the experience gained was put to good use eight years later when Pat and Josephine Mackerras participated in expeditions to Mitchell River mission (now Kowanyama), led by Dr R.L. Doherty of the Queensland Institute of Medical Research (QIMR). The mosquitoes they collected yielded Murray Valley Encephalitis virus, along with at least eight other viruses new to science, results which guaranteed the continuation of the QIMR Arbovirus Research Programme.

In 1958 Pat spent three months collecting mosquitoes in New Guinea, supported by the Bernice P. Bishop Museum in Hawaii. She travelled widely to remote villages by small planes and rivercraft, mostly in the then Australian Territory of Papua New Guinea but she also had the opportunity to visit then Dutch New Guinea [now the Indonesian Province of West Papua] and made a long journey up the Mamberano River (Fig. 3) with Dutch entomologist, Hans van den Assem. The mosquitoes of New Guinea were a continuing interest and she visited the area four more times during her career.

In 1962 Pat moved with the Entomology Department when it relocated from George Street to the St Lucia campus of the University of Queensland. It was my impression that Pat was happiest in the university environment in the company of other entomologists and interacting with postgraduate students. Pat seems to have had much the same opinion: 'I had moved with the University to St Lucia where I worked in the Goddard Building, which was shared with the Zoology Department. I had a lovely big room there and I think I did my best work in that room' (Marks and Cummins 2004, p. 145).

Table 1 summarises some of Pat's activities. In the period spent at the University of Queensland, she described 37 new species of mosquito (see Appendix), collected a further 43 species she considered to be new, allocating species numbers to them and putting them aside for later study. The days of describing a new species from one specimen had long gone, so lack of adequate material, both male and female, may have been one factor, while lack of link-reared larvae and pupae may have been another.

Table 1. Productivity of E.N. Marks during different phases of her career.

LOCATION	Queensland University (George Street)	Queensland University (St Lucia)	Queensland Institute of Medical Research
Period	1940 – 1961	1962 – 1976	1977 – 1983
Published papers	39 mosquitoes 2 other	37 mosquitoes 28 other	18 mosquitoes 7 other
New species described	27	10	1
New species allocated Marks code numbers	9	34	17

Pat usually published new species in related groups with a review of the relationships within the group; occasionally she published single species. In 1954 she published a review of the *Aedes scutellaris* subgroup, which contained a number of closely related and morphologically similar species. The group was of medical importance, as it contained vectors of both filariasis and dengue fever and was widely distributed in the Pacific. In studying the group, Pat noted that one species, *Aedes pseudoscutellaris* (Theobald), was a mixture of two species and named the new species *Ae. polynesiensis* Marks, publishing it alone, as it was important to rapidly spread the news. *Aedes polynesiensis* was shown to be a good vector of both filariasis and dengue. While Pat solved a species problem she produced one for the epidemiologists: which species had they been working with all these years?

When I started working with mosquitoes in 1953, Edwards (1925) was the standard text, supplemented by wartime handbooks. Many of the descriptions in Edwards were brief and inadequate. I remember Pat describing them as 'heads and tails'. Pat changed this - her descriptions covered the whole insect in great detail, both male and female, often including descriptions of larvae and pupae. When appropriate, she would review the genus or subgenus, producing keys to adults and larvae and including notes on the breeding sites and distribution.

When it came to Pat's research, I and many of my colleagues were, and still are, end users. Our aim was to collect as many mosquitoes as possible, identify them to species while still alive, freeze them in liquid nitrogen, then homogenise them and inoculate them into tissue culture or day old mice - not quite the way Pat was used to treating her pets.

In conclusion I have many memories of working with Pat, who never considered herself infallible. Many of us were certain she was. On one occasion, after the Pacific Science Congress in Dunedin, New Zealand, I was interested in what I considered to be the odd distribution of *Culex annulirostris* Skuse in the Pacific. I told Pat I had serious doubts about the validity of many of the identifications, except for one island group where the mosquitoes had been identified long ago by Miss E.N. Marks. Pat's reply was 'Harry, what makes you think I knew what *annulirostris* was in those days?'

Pat has left a legacy which places every mosquito worker in Australia in her debt. Her descriptions of new species and redescriptions of poorly described species, together with revisions of sub-genera and species groups and the numerous keys in the *Culicidae of the Australasian Region*, ensures that we are continually referring to works by E.N. Marks.

I find it difficult to do justice to Dr E.N. Marks with such a brief note except to say that I was enriched both as a person and as a scientist by knowing her and I sorely miss being able to solve my problems by 'going to see Pat.'

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Appendix

New species of mosquitoes described by E.N. Marks

Species are arranged chronologically by year of description and are cited in their original combination. Country of type locality is given and those where the holotype was collected by E.N. Marks are indicated with *.

Aedes (Finlaya) bougainvillensis Marks, 1947. Solomon Islands.
Aedes (Finlaya) fijiensis Marks, 1947. Fiji.
Aedes (Finlaya) alocasicola Marks, 1947. Queensland.
Aedes (Finlaya) gahnicola Marks, 1947. Queensland.
Aedes (Finlaya) candidoscutellum Marks, 1947. Queensland.
Aedes (Finlaya) wasselli Marks, 1947. Queensland.
**Aedes (Finlaya) monocellatus* Marks, 1948. Queensland.
Aedes (Finlaya) subauridorsum Marks, 1948. Queensland.
Aedes (Ochlerotatus) pseudonormanensis Marks, 1949. Queensland.
Aedes (Ochlerotatus) perkinsi Marks, 1949. Queensland.
Aedes (Stegomyia) polynesiensis Marks, 1951. Fiji.
Aedes (Finlaya) iwi Marks, 1955. Queensland.
Culex (Neoculex) cheesmanae Mattingly and Marks, 1955. New Caledonia.
**Anopheles (Anopheles) colledgei* Marks, 1956. Queensland.
Aedes (Stegomyia) upolensis Marks, 1957. Samoa.
Aedes (Ochlerotatus) calcariae Marks, 1957. South Australia.
Aedes (Finlaya) britteni Marks and Hodgman, 1958. Western Australia.
**Aedes (Finlaya) josephinae* Marks, 1958. Queensland.
Aedes (Finlaya) dobrotworskyi Marks, 1958. Victoria.
Aedes (Ochlerotatus) hodgkini Marks, 1959. Western Australia.
Aedes (Ochlerotatus) macintoshi Marks, 1959. Western Australia.
Aedes (Ochlerotatus) ratcliffei Marks, 1959. Western Australia.
Aedes (Ochlerotatus) hesperonotius Marks, 1959. Western Australia.
Aedes (Ochlerotatus) purpureifemur Marks, 1959. Western Australia.
Aedes (Finlaya) plagosus Marks, 1959. New South Wales.
**Topomyia papuensis* Marks, 1960. Papua New Guinea.
Aedes (Ochlerotatus) subalbirostris Klein and Marks, 1960. New Zealand.
Aedes (Chaetocruiomyia) calabyi Marks, 1963. Western Australia.
Aedes (Ochlerotatus) spilotus Marks, 1963. Victoria.
Aedes (Ochlerotatus) turneri Marks, 1963. Western Australia.
Aedes (Ochlerotatus) cacozelus Marks, 1963. Western Australia.
Aedes (Chaetocruiomyia) macmillani Marks, 1964. New South Wales.
**Aedes (Ochlerotatus) explorator* Marks, 1964. Northern Territory.
Aedes (Ochlerotatus) linesi Marks, 1964. South Australia.
Aedes (Ochlerotatus) phaecasiatus Marks, 1964. Northern Territory.
Aedes (Ochlerotatus) sapiens Marks, 1964. New South Wales.
**Culiseta arenivaga* Marks, 1968. Queensland.
Aedes (Macleaya) stoneorum Marks, 1977. Queensland.

THE ROLE OF PAT MARKS IN THE AUSTRALASIAN MOSQUITO CATALOGUE PROJECT AND FUTURE NEEDS IN MOSQUITO TAXONOMY

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Abstract

Elizabeth Nesta ('Pat') Marks was a major participant in the compilation of the twelve volume annotated bibliography of the mosquito fauna of the Australasian Region. This work provides mosquito workers with easy access to data on all the described species within the region. Pat developed keys for the identification of female specimens of all species within the region.

Pat Marks' contribution to *The Culicidae of the Australasian Region*

The Culicidae of the Australasian Region was a collaborative project initiated by the late Professor David Lee, who was formerly the Head of the Entomology Section of the Sydney School of Public Health and Tropical Medicine. Unfortunately David died soon after the completion of this work but Pat Marks lived to enjoy its completion (Fig. 1).

The Australasian Region includes Australia, New Zealand, New Guinea and islands north to the equator and east to 180°E. It is defined in the northwest by a line drawn around the western coast of the Moluccas, Ceram and Timor. The volumes also cover islands to the north of the Equator such as Hawaii, Kiribati and Tuvalu (formerly known as the Gilbert and Ellice Islands). Many of the islands in the region have endemic species of mosquitoes. Throughout the tropical areas, mosquito-borne diseases such as malaria, lymphatic filariasis and arboviruses are major public health problems but the entomological skills and resources are limited or nonexistent.

For those of us who work or have worked with control of mosquitoes and the diseases they carry, *The Culicidae of the Australasian Region* has been and will continue to be an invaluable resource. The volumes are of even greater benefit to those working in developing countries where library resources are very limited.

As stated in the introduction to Volume One of this series of publications, the authors attempted to include, for all species of mosquitoes that had been recorded in the region, all the literature relating to their occurrence in the region and important references to these species in literature from other regions. For example, a number of medically important species in the region, notably *Aedes aegypti* (L.), the vector of the viruses that cause dengue fever, have been introduced into the region and a great deal of the literature on their biology, behaviour and role in disease transmission comes from work in other zoogeographic regions.

For each species treated in *The Culicidae of the Australasian Region*, details of the original description are provided, including which stages (adult, whether male or female, larva or pupa) were described, and information is given on the type specimen (stage, sex and where it is located). Some widespread species were named on more than one occasion and Pat's expertise was invaluable in unravelling whether the often meagre descriptions referred to the same or different species. Wherever possible, Pat examined the type specimen in her quest to determine the truth.

For each species, the literature pertaining to that species was listed chronologically with notes indicating the contents. For well studied species, such as *Culex annulirostris* Skuse, the vector of Murray Valley encephalitis virus and Ross River virus, the literature listing is very extensive and in this example covers 26 pages, in spite of the notes attached to each reference being very succinct (*e.g.* 'Tas distribution', 'seasonal activity', 'abundance', 'Echuca', etc).

The information from the literature was synthesized and summarised to provide information on distribution, biology (including larval habitats), associated species, female host preferences, time and place of biting by females, and relation to disease.

The task of compiling the data from over 3700 articles and reports was massive and is reflected in the size of the finished product. *The Culicidae of the Australasian Region* runs to over 3,000 pages in 12 volumes and includes literature dating from 1810.

A great deal of the value of the checklist is due to its providing information from articles that are inaccessible to most readers. These include reports from Health Departments of small island governments (*e.g.* annual reports of the Fiji Medical Services), publications of the Armed Forces of Australia and the USA, abstracts of scientific conferences and annual reports of research institutions. Such sources have provided a wealth of information that is not available in the scientific literature. Many of these articles were from Pat's own extensive literature collection. Over 200 articles were not in English and had to be translated before their information could be extracted. The foreign language papers largely reflect the colonial history of the Region, with articles in Dutch on the mosquitoes of West New Guinea [now West Papua] and some German language articles, prior to World War One, on mosquitoes in the northeastern part of what is now Papua New Guinea. Publications from New Caledonia are still being written in French, while much of the literature on the vectors of aperiodic lymphatic filariasis is also in French.

We now have readily available information on 620 species of mosquitoes that are known to occur in the region. For many of these species, no new information has been collected since the publication of *The Culicidae of the Australasian Region*.

Fig. 1. Pat Marks (left) and Joan Bryan at the launch of the 12-volume *The Culicidae of the Australasian Region* at the University of Queensland Medical School in 1990.

Brief information is also provided on 74 species that have been wrongly recorded from the Region, either due to misidentification of specimens (especially in the early years, bearing in mind that publications reviewed date from 1810), or because some islands were incorrectly assigned to the Australasian Region (*e.g.* Palau). Recently developed data retrieval systems have made information in articles published since the completion of *The Culicidae of the Australasian Region* much more readily available so I see no need for a revision.

An outstanding achievement associated with the publication of *The Culicidae of the Australasian Region* was the development of keys to identify female mosquitoes, first to genera, then to subgenera (where applicable - not all genera have subgenera) and to species. For the first time, mosquito workers could identify any female mosquito from within the region. The development of these keys was largely Pat's work. Those of us who have tried to prepare identification keys appreciate that this is a complex and difficult process and requires a detailed knowledge of the morphology of the species. Pat certainly had the right credentials for this work. Without the ability to identify specimens, the collation of information on the individual species would have had little value. With few entomologists in many countries within the region, the keys are a lasting gift to those battling mosquito-borne diseases in our neighbouring countries.

The task of compiling *The Culicidae of the Australasian Region* was far bigger than Pat or her colleague David Lee envisaged. I first became aware of their dream to produce a summary of the literature on the mosquitoes of our Region when I was an honours student in the early 1960s, as Pat voiced her discomfort at her delayed response to David's request for comments on early drafts of the first few volumes. Such a 'delayed response' was a feature of Pat's participation in this work, as many other interests took precedence over this huge, and what must have seemed at times impossible to finish, project. Pat and David, while acknowledging the 'magnitude of the task' in their introduction to Volume One, continued optimistically: 'despite many vicissitudes, production is now under way and we hope the interval between the first and final volume will not exceed two years.' Volume One was published in 1980, but by 1982 only Volume Two had been published. Another seven years and a $100,000 grant from the Commonwealth Government were needed before their dream became reality. The long delay necessitated an additional bibliography (in Volume 12) to cover literature published after the original bibliography was published in Volume One. Here I would also like to acknowledge the dedicated work by the late Mabel Griffiths, Megan Hicks and Margaret Debenham, ably assisted by Richard Russell, Merilyn Geary and others. Completion of the work was greatly aided by the advent of word processors. In spite of the input by others and technological advances, the work relied on scientific input from Pat and David and without them the task would never have been completed. Many of us have grandiose dreams but few see them realised; we are in the debt of the great dreamers.

Future needs in mosquito taxonomy in the Australasian region

Pat herself recognized many species that remain undescribed and her collections contained specimens of at least 43 undescribed species. Many of these are included in the keys in *The Culicidae of the Australasian Region* under code numbers. Sadly, formal taxonomy fails to attract funding and

no one has followed in Pat's footsteps, so there is no immediate prospect of these morphologically distinct species being described.

We also need descriptions and names for those species that cannot be identified by their morphological features, either because they are identical morphologically to other species or they share a variable morphology with other species. An extreme example of this problem is highlighted by *Anopheles annulipes* (Walker), once thought to be a single species. Molecular genetic techniques have revealed the presence of 18-25 species that conform to the description of *An. annulipes (*Foley *et al.* in press).

The importance of correct identification of morphologically indistinguishable species is well illustrated by two species that occur in the Solomon Islands. They would both be identified as *Anopheles farauti* Laveron using the keys in *The Culicidae of the Australasian Region*. However, one species, now named *An. irenicus* Schmidt (Schmidt *et al.* 2003), does not feed on humans and therefore is not implicated in transmission of malaria, whereas *An. farauti* is the major vector of malaria throughout the southwestern Pacific. The presence of larvae of *An. irenicus* could cause control efforts to be misdirected. We need good identification tools before we can develop appropriate control strategies.

For most genera, identification keys for larvae still need to be developed. Given the high degree of endemism, keys for the species within each country will be more appropriate and easier to develop than keys for all species within the region. Keys have been constructed for container-breeding larvae in some South Pacific countries but much remains to be done.

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URBAN MOSQUITO MANAGEMENT IN BRISBANE – PAST, PRESENT AND FUTURE

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Abstract

The history of the management of pest mosquito populations in the city of Brisbane and adjacent areas is described. The evolution of techniques, over almost a century, from the earliest attempts at larval control by manual oil application to water bodies, through to modern, highly targeted, computer controlled, aerial application of highly specific chemicals is outlined. The role of mosquito specialist Dr Elizabeth Marks in these events is highlighted.

Introduction

Brisbane is a subtropical city straddling the low-lying estuary of the Brisbane River, with its adjacent mangroves and saltmarshes. This situation poses many potential problems for mosquito control and the way these have been tackled has evolved over the years. For the early years this summary draws heavily on an address in 1960 to the Entomological Society of Queensland by J.D. Mabbett, then Chief Health Officer of Brisbane City Council (Mabbet 1960).

Events prior to the 2nd World War

In 1912, the Queensland Commissioner of Public Health, Dr J.S.C. Elkington, arranged a preliminary mosquito survey in Brisbane and suburbs under Lance Cooling. This led to the first mosquito regulations in the same year, but by 1921 the only organised activity was oiling of gully traps in parts of Brisbane, South Brisbane, Toombul and Toowong.

In 1921, the 'Mosquito Prevention and Destruction Regulations' were introduced to control *Aedes aegypti* (L.). Cooling was urging local authorities to provide permanent means of foul-water drainage to control *Culex fatigans* Wiedemann [now *Culex quinquefasciatus* Say]. This species was the known vector of filariasis, common in Brisbane at the time.

When Greater Brisbane was established as a single Council in 1925, the Medical Officer, Dr Tilling, arranged quicker coverage of gully traps by providing a horse and buggy. In 1928, the Council appointed Dr Ronald Hamlyn-Harris as City Entomologist, in response to concern about mosquito control. Staff comprised a supervisor, four mosquito locators and four sprayers. In 1932, the section was using three tricycles (Fig. 1) to speed up treatment of gully traps. In 1934, three motorcycle units were introduced. The program targeted mosquito larvae, using various oils and kerosene mixtures as larvicides.

Figs 1-2. (1) Bicycle-carried oil equipment being used against mosquito larvae, Brisbane City Council, date unknown. (2) The Brisbane City Council mosquito control team, 1959.

The new era following the 2nd World War

The impact of the Second World War on interest in mosquitoes in Australia was very significant, due to concerns about malaria in the South Pacific and Southeast Asia, and the possibility of returning soldiers bringing malaria parasites home. There was also a serious epidemic of malaria in Cairns in 1942. After the war, many ex-servicemen with war-time experience in pest control were employed by Brisbane City Council. Many of these men would have been trained during the war in courses run at the University of Queensland by Mr F.A. Perkins of the UQ Entomology Department, with Elizabeth (Pat) Marks as their instructor. In the three years following the war, a complete re-survey of mosquitoes in Brisbane was undertaken, with particular attention paid to *Anopheles* because of the malaria issue. Larvicides in use after the war included DDT and malariol.

In 1949, Brisbane was divided into ten zones, with men and motorcycle units designated to each. Gully traps were also covered in a separate control schedule. In 1950, Council purchased its first truck-mounted, thermal-fogging machine for adult mosquito control, and by 1960 there were four of these units (Figs 2, 3). However, control of mosquito larvae was still the main task of the program. One product used successfully for this was 'Larvabane', based on benzene hexachloride, claimed to be 'very toxic to mosquito life but safe to beneficial fish life'. During the 1950s, 'house to house inspections and remedial action' led to the virtual elimination of *Ae. aegypti* and the claim that 'dengue has been beaten'. (There had been an outbreak of dengue in Brisbane in 1905 that was reported to have incapacitated one third of the work force and caused many fatalities, and there were other outbreaks up to and including the 1940s).

In the 1950s, *Culex annulirostris* Skuse began to take the place of *Cx. fatigans* as drainage and sanitation improved. This change also coincided with the disappearance of filariasis carried by *Cx. fatigans*. However, the major pest mosquito at the time was the 'migratory black swamp mosquito, *Aedes vigilax* (Skuse).'

As mentioned above, Dr Elizabeth (Pat) Marks played a part in much of this early mosquito management. She graduated from the University of Queensland with a B.Sc. in 1938, with Second Class Honours in Zoology in 1939 and an M.Sc. in 1940. For her Honours, she specialised in parasitology and was supervised by the former Brisbane City Council Entomologist Hamlyn-Harris, who had become a lecturer in Zoology at the University. He took her collecting mosquitoes in Brisbane and this led to her first scientific publication in 1940, a description of the larva of *Anopheles atratipes* Skuse. Following the malaria epidemic in Cairns in 1942, the Queensland Government established a Mosquito Control Committee (MCC), with the Director of Health as Chairman and F.A. Perkins as Secretary. On 1 April 1943, Pat Marks became the MCC's Graduate Research Assistant, based at

Figs 3-4. (3) 'Demonstration of Modern Pest Control Equipment used by Department of Health, Brisbane City Council' at the City Hall during National Health Week in 1960. Mr J.D. Mabbett is on the steps. (4) The Brisbane City Council Mosquito Control Bike Team, 1980s.

the UQ Department of Entomology and funded by the State Health Department. Apart from her time at Cambridge from 1949-1951, Pat was to occupy this position (with various changes of title) until the MCC was dissolved by the government on 30 June 1973. During that time, she had regular interaction with the Brisbane City Council mosquito control managers, including J.D. (Doug) Mabbett, Chief Health Officer of Brisbane City Council up until 1974.

In 1964, the Brisbane City Council mosquito control group had a permanent staff of 50 and was spending £80,000 annually on control of *Cx. fatigans* in man-made polluted sites. An aerial survey had been conducted from the Mooloolah River to the Tweed River to identify potential saltmarsh breeding sites. For saltmarsh mosquitoes, Mabbett was advocating a combination of land reclamation and an overarching Moreton Bay Regional Control Mosquito Abatement District, for all Local Authorities and the State Government to operate on a joint basis. This initiative was pursued vigorously by a range of pre-eminent mosquito workers, including Pat Marks, Harry Standfast at Queensland Institute of Medical Research (QIMR), Professor Douglas Kettle at the University of Queensland and a number of local government bodies. However, the State government of the day rejected the proposal out of hand. Keith Ferguson of the Gold Coast City Council, tiring of government inaction, established the Contiguous Local Authorities Group (CLAG) in 1968. This group included Gold Coast, Logan, Redland and Albert cities and shires in Queensland, and Tweed shire in New South Wales. CLAG is still functioning and was the forerunner to other successful groups in southeast Queensland that are operating today.

One interesting exercise associated with *Ae. vigilax*, on 6 March 1964, was a fogging exercise around Bulwer Island on the north bank of the Brisbane River at Pinkenba. On that afternoon, Her Majesty Queen Elizabeth II was scheduled to unveil a Memorial Cairn at an oil refinery to mark the discovery of oil in Queensland. The cairn and the Royal pavilion erected for the occasion were within 30 metres of mangroves where prolific numbers of *Ae. vigilax* were resting. The workmen erecting the pavilion had complained of constant attack by both mosquitoes and march flies (Tabanidae). On the day of the function, commencing early in the morning, both vehicle-mounted and hand-held fogging equipment were used to apply 'knockdown and residual formulations' around and through the adjacent mangroves. The last of these applications, in the two hours before the ceremony, also included the repellent diethyl toluamide (DEET). All of this produced 'highly favourable results' and 'the function was held without insect nuisance.' Mabbett published a note on this operation in the American journal *Mosquito News* (Mabbett 1964). The Editor commented that 'There are several points and expressions in this article that may not be entirely clear to readers in other parts of the world, but it is so seldom that we hear from Australia, and the

operations described are so interesting, with many useful hints, that it seemed worthwhile to print the account more or less as received.'

The beginning of aerial application techniques

Mabbett was opposed 'in principle' to aerial control of mosquitoes because of its 'hit and miss' nature and potential non-target impacts. However, in 1970, the Council of the day went ahead with a trial of an aerial application of Dibrom, an organophosphate insecticide, aimed at adult *Ae. vigilax* resting in mangroves in the Cribb Island area. A number of scientists, including Harry Standfast, Pat Marks and Geoff Monteith, had spoken out against the trial in its planning stages, labelling it as haphazard. On 17 January, the trial went ahead and the resultant fish kill was featured in the Sunday Mail the following day, with entomologist Geoff Monteith pictured holding a handful of small, dead fish.

However, efforts to establish aerial control of saltmarsh mosquitoes continued, with the target being larvae rather than adult mosquitoes. This was pioneered in the early 1970s on the Gold Coast by Brian Kay of QIMR, Keith Ferguson of Gold Coast City Council and Dick Morgan of Cyanamid. The product used was a sand grain organophosphate formulation called Abate, a larvicide applied into saltmarsh pools by biplanes. By 1976, an aerial program was operating in Brisbane. Abate was the mainstay of the aerial program until the early 1990s. A liquid formulation was also used by ground staff to target mosquito larvae in both freshwater and saltmarsh pools. Motorcycles with sidecars were a regular feature of the program throughout the 1970s and 1980s (Fig. 4), with the last operator (and sidecar bike) retiring in 1997.

In the early to mid-1990s, laboratory studies using Abate determined that it was potentially harmful to juvenile crustaceans. Bench-top susceptibility tests also revealed that *Ae. vigilax* was developing resistance to this product. It was quite fortuitous that, at this time, two alternative products became available. These were the bacterial protein Bti and the growth regulator S-methoprene. Both products have excellent selectivity for mosquito larvae and are very safe for invertebrate and vertebrate non-target animals.

Bti is produced in a fermentation process by the naturally occurring soil bacteria *Bacillus thuringiensis* var. *israelensis* de Barjac. The active ingredient is a crystalline protein of approximately 10 microns in length that must be eaten by mosquito larvae to have its effect. In the alkaline pH of the larval gut, the crystal breaks down and releases proteins that disrupt the cells of the gut wall and cause the death of the larva, usually within 24 hours. Bti is available in liquid, powder and granular formulations.

S-methoprene growth regulator interferes with the moulting process that occurs between larval stages and between the final larval stage and the pupa.

Figs 5-6. (5) Using a remote-rewind hose unit to treat freshwater mosquito breeding with Bti. (6) A quad bike spraying Bti on saltmarsh mosquito breeding pools in Tinchi Tamba Wetlands.

Figs 7-8. (7) A Bell 47 helicopter applying Bti to saltmarsh pools in Tinchi Tamba Wetlands. (8) The lines on this aerial photograph of Tinchi Tamba Wetlands show the flight path downloaded from the helicopter's GPS unit after an application of S-methoprene on 28 February 2006.

S-methoprene is available as a liquid, in a sand base, and in slow-release charcoal matrix pellets and briquettes.

These products have become the mainstays of mosquito management in Brisbane City Council since 1994. They are used for aerial application from helicopters in saltmarsh areas, and by ground-based staff from four-wheel drive utilities and quad bikes (Figs 5, 6). The capacity to carry out adult mosquito control using fogging or ultra-low-volume misting is maintained, but is rarely used.

Currently, for mosquito management in Brisbane City Council, there are approximately 18 field staff and an annual budget of approximately $3.2 million. The aerial program each year plans to cover 25,000 hectares of saltmarsh in a season from August to May, usually in approximately 20 separate treatments. However, both the total area and the timing can vary with seasonal conditions. Differential Global Positioning Systems are now used routinely in the aerial program, and spray flight paths are overlayed on aerial photographs for every treatment (Figs 7, 8). DGPS is also being used more frequently in ground-based management. For the latter, Brisbane City is divided into nine different sections and a total of approximately 3,000 known and potential mosquito breeding sites on public land are listed on separate databases for each of those sections. The databases include sites such as roadside drains, parks and reserves, and information on the tide heights and rainfall triggers that can initiate mosquito breeding at those sites. The target is to check and treat them in a logical order at intervals short enough to prevent mosquitoes from completing their life cycle.

Brisbane City Council, along with other local government bodies in southeast Queensland, other Councils elsewhere in Queensland and interstate, one industry member and Queensland Health, is a member of the Mosquito and Arbovirus Research Committee Inc. (MARC). Members of MARC contribute funds to a research program at QIMR that studies aspects of mosquito biology and disease transmission, and environmentally sound mosquito control. This group commenced in 1989 with the aim of providing a solid scientific base for mosquito management. It was also a recognition that mosquitoes move freely across local government boundaries. MARC supports a full-time scientist and a number of postgraduate and postdoctoral students based mainly in the mosquito control laboratories at QIMR.

Looking to the future

There will be further challenges in the future. In southeast Queensland, there are significant pressures on development and infrastructure in coastal areas, due to the steady influx of new residents from southern States. Many of these will move into the 'pest range' of saltmarsh mosquitoes in their desire to live adjacent to the coast. And many of the new real estate developments are incorporating what is known as 'Water Sensitive Urban Design' for management of storm water run-off. These features are initially designed to

be free of mosquito breeding, but based on experience elsewhere, there are likely to be significant issues with maintenance of these drains in the future. Also, the recent recognition of water as a finite resource means a resurgence in the use of water tanks and various other containers to store water. While modern plastic water tanks certainly have better mosquito-proofing than the old corrugated iron variety, there may be issues with their maintenance in the future that will need to be monitored.

Modern mosquito management has naturally become far more sophisticated and has excellent products and equipment available. And there is now a much clearer recognition that mosquito management programs are carried out in environmentally sensitive and important habitats that require significant duty of care. However, the challenges of knowing the biology and distribution of pest species, and of dealing with them in a variety of seasonal conditions, are still very similar to those faced in earlier times. The one constant in mosquito management is that the target insects are so brilliantly adapted to taking advantage of any ecological niche they find in nature. Skills and experience of mosquito management operators are an essential ingredient of keeping these pests under control. They will be necessary along with ongoing scientific studies to keep mosquito pests and mosquito-borne disease at bay into the future.

Regardless of any current and future studies, all those working in mosquito management will continue to refer to the legacy left by Pat Marks. There will be frequent use of identification keys that she prepared, and regular referral to her publications on the taxonomic descriptions and biology of a vast range of Australian mosquitoes. The recollections given and the broad spread of the presentations in this Symposium have been a fitting commemoration of a remarkable scientific career.

Acknowledgements

This paper could not have been prepared without the accurate recording of the address by J.D. Mabbett to the Entomological Society of Queensland on 14 November 1960, and provision of those Minutes to me by Dr Geoff Monteith of the Queensland Museum. I also thank Harry Standfast for his review of the manuscript and his recollections that helped to fine-tune some of the historical data.

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SCIENTIFIC ITEMS IN THE MARKS COLLECTION AT THE QUEENSLAND MUSEUM

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Abstract

The Marks Collection is the largest body of material items from a single family in the Social History collection of the Queensland Museum. In social history terms, the collection is a slice through the life of a well-to-do Brisbane family, mostly from between the two World Wars, and includes a few items which, in their own right, are of international significance. Scientific objects are a small part of the collection but reflect the family's scientific interests, both as scientific practitioners themselves, and as a family with broader interests in popular science.

Introduction

Comprising more than 2000 items, the Marks Collection in the Social History collection at the Queensland Museum forms the largest body of material from a single family in that collection. It is one of several donated collections of both historical and scientific items from that family in the Queensland Museum and other institutions. Others include materials in the Samford Museum, the John Oxley Library and the Queensland Art Gallery, and the E.N. Marks mosquito collections in the University of Queensland Insect Collection (Schneider and Daniels 2006). While this article is primarily concerned with items in the Queensland Museum Social History collection, the contribution of the Marks family to these other collecting institutions has been remarkable and deserves fuller documentation. These collections offer valuable possibilities for research in several different directions, including the material culture of the Marks family itself. Indeed, it has been suggested that it would be useful to develop a single database of the various Marks collections so they can be researched together.

Marks family items in the Queensland Museum Social History collection

The collection includes items from a number of different members and branches of the Marks family, though it is particularly identified with entomologist Dr Elizabeth Nesta Marks (1918-2002). Known to all as Pat Marks, she was the last member of her branch of the family and was the conduit of much of their collection to the Museum. The recent re-storage of the collection was also due to her, being funded by a generous donation from the Marks estate following her death in 2002.

As far as the Queensland Museum is concerned, the Marks Collection dates from 1919, when Dr Charles Ferdinand Marks (grandfather of Pat Marks) donated a convict leg-iron and chain recovered that year from a dig at the Treasury Building, now the Casino. He also gave the Museum a piece of raw rubber. The jewel of the collection is the Tompion clock (Fig. 1), donated by Alexander Hammett Marks (uncle to Pat Marks) in 1954. Thomas Tompion is known as the father of English clockmaking (Evans 2006). His partnership

with Edward Banger lasted from 1700 to 1708, when they parted suddenly (apparently in anger), after achieving unparalleled heights of craftsmanship. They made this clock in 1706. Tompion combined English technical advances with his own superb workmanship, and ingenious designs, to produce timepieces that contributed vastly to the fame of English clockmaking in the late 17th and early 18th centuries. Their clocks were numbered and this one is 435. Marks and Cummins (2004) record that the Tompion clock originally belonged to a Miss Reade who had a ne'er-do-well nephew and gave the clock to her neighbour, Pat's grandmother, to keep it out of his hands.

Fig. 1. The Tompion clock (H-4).

The bulk of the collection dates from a small number of major donations over the past 40 years. Miss Edris Marie Blanche Marks (aunt to Pat Marks) made a major donation in 1978 and Pat Marks, both in her own right and from Edris Marks' estate, gave the Museum a large quantity of material in 1982, collected by then Senior Curator of History and Technology, Dan Robinson, from the Marks residence at 101 Wickham Terrace prior to its sale. This comprises a large quantity of domestic items. Museum space issues would prevent such a donation today, but the fact that it was possible then has led to the Museum's possession of a collection remarkable, not only for major

objects, but also for its range of ordinary things. These together represent a large slice of the material culture of one Brisbane family, and are particularly rich for the period between the two World Wars.

From a completely separate stream of donation, the Queensland Museum also has 1224 anthropological items from the Marks family, including important Aboriginal items plus many from Papua New Guinea. Pat reported that some of these had been given to her grandfather by Sir William Macgregor, and came to the Museum because her mother refused to have them in the bedroom (Marks and Cummins 2004).

The collection totals more than 2000 items and covers a remarkable range. There is, for example, Alec (A.H.) Marks' important gun collection from the 1940s, including a wonderful pair of Manton pistols (Fig. 2). Joseph Manton (1760-1835) was a renowned British gunsmith who made important innovations in the design and construction of both duelling pistols, such as these, and of artillery. The Queensland Museum pistols are particularly fine examples of his art.

Fig. 2. A pair of Manton duelling pistols (H-2022-23).

Also included is the remarkable ball gown (Fig. 3) made by Brisbane costumier Janet Walker, who worked in Brisbane between 1882 and 1938 (Marendy 2005). The gown was donated in 1998 and was later restored by Brisbane textile conservator, Michael Marendy, with assistance from the

Marks estate. Mrs Walker operated the largest private dressmaking establishment in Brisbane and, by 1898, employed 120 staff. Several of her gowns were worn at the opening of the Commonwealth Parliament in 1901.

Less spectacularly, the Marks Collection also includes: locks and doorknobs; office equipment; male bathing costumes from the 1940s; Elizabeth Drury's angora goat awards from the Brisbane Show before World War I; 468 ordinary items of domestic life at 101 Wickham Terrace; handcraft items (sewing, knitting and crochet); timepieces, the most valuable component, though not the most numerous, including the Tompion clock and two important chronometers; examples of gas, kerosene and electric lighting technologies; medical items; militaria, including gas masks from both World Wars; musical items; nursery toys; 239 packages and containers from 1870 to 1920; many personal effects and toiletries; photographic equipment; tools relating to carpentry, horology, hairdressing, jewellery, gold leaf application and painting.

Fig. 3. A ball gown made by Janet Walker (H-42023).

Scientific items in the Queensland Museum Marks collection

Relatively few (151) of the items could be called scientific, and these on the whole are not the most significant items in the collection. Pat Marks' own career as an entomologist is well known (Anon. 1986, Standfast 2006) and her father, Edward Oswald Marks, was a Brisbane doctor like his father before him, so the Marks family had a strong preoccupation with science. At the same time, the family was well-to-do and able to follow popular scientific interests of the day, particularly in geology and natural history. The scientific items in the collection reflect these influences. They include: a number of compasses; a Sikes hydrometer; a prismatic level; a beam balance; a number of sets of scales; a number of thermometers; a spirit lamp; a revolution counter; a set of postal scales; a wooden set-square; a set of scales and weights, including a hand-held beam balance and weights; a number of test tubes, funnels and pipettes; microscope slides; a spinthariscope; centrifuge tubes; graduated cylinders; Bunsen burners; a copper pencil; a carbon filter; beakers; magnifying glasses; a travelling microscope; microscope slides; microscope lenses, eye pieces and accessories. Six of these items are pictured (QM photographs) and described here.

Sikes hydrometer, H-10987 (Fig. 4)

How this item came into their possession is not known, but it is a typical Marks curiosity, used to measure the proof of spirits. Sikes hydrometers have a curious history. 'In 1802 the Board of Excise held a competition to find a better instrument than Clarke's hydrometer for revenue purposes ... The winning design was that of Bartholomew Sikes, a peripatetic London employee of the excise commissioners. Sikes' hydrometer was enshrined in legislation in 1816 with the Sikes Hydrometer Act and remained the legal standard until 1907' (*http://www.promash.com/sikes/history.html* 13-10-2005).

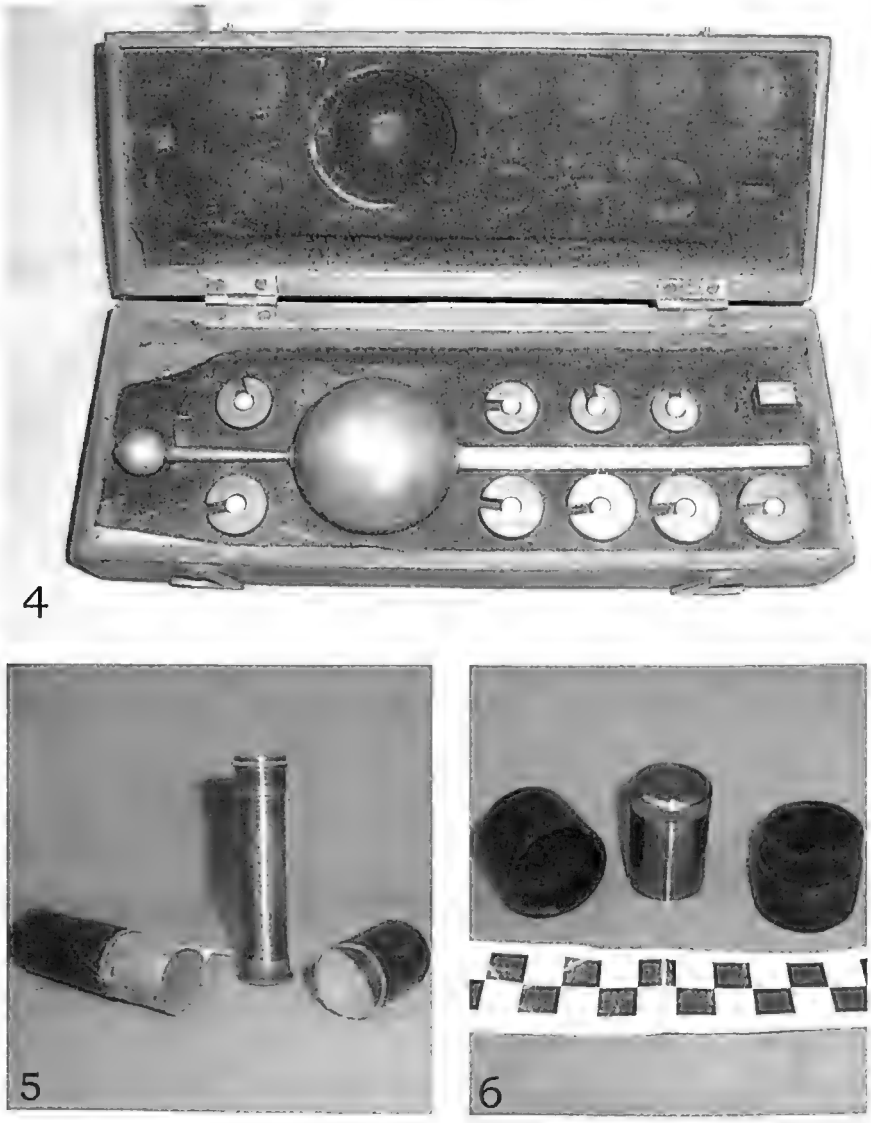
Pocket microscope, H-12783 (Fig. 5)

Who used this microscope is not clear, though it may have been a suitable instrument for Pat Marks on her field trips. The microscope was made by Horatio Yeates of Dublin, and is thus marked. Its date of manufacture is not certain.

Spinthariscope, H-23659 (Fig. 6)

This is another Marks curiosity. 'A spinthariscope is a now almost entirely disused scientific device for observing individual radioactive decay nuclear disintegrations ... invented by William Crookes in 1903 ... a device specifically intended to view these scintillations ... It consisted of a small screen coated with zinc sulfide affixed to the end of a tube, with a tiny amount of radium salt suspended a short distance from the screen and a lens on the other end of the tube for viewing the screen ... for a short time after its invention, spinthariscopes were very popular among the social upper classes

who gave them as gifts and used them in demonstrations to appear up-to-date with the most modern scientific advances of the day' (Wikipedia, *http://en.wikipedia.org/w/index.php?title=Spinthariscope&action=edit* 12-10-2005).



Figs 4-6. (4) A Sikes hydrometer (H-10987). (5) A pocket microscope (H-12783). (6) A spinthariscope (H-23659/1 & 2).

Fig. 7. Pat Marks' collecting bag (H-46713).

Collecting bag, H-46713 (Fig 7)

This is Pat Marks' collecting bag, used on her field expeditions. It is a khaki, army-style bag, with two carry straps and a shoulder strap, a single zip and six internal pockets. Its dilapidated state is a clue to the sentimental attachment she felt towards it, which will no doubt be recognised by many other collectors.

Field microscope, H-46212 (Fig. 8)

This instrument dates from around 1800 and was Pat Marks' last donation to the Museum before her death in 2002. It had been given to the young Charles Ferdinand Marks in the 1860s by a very old man in Ireland. C.F. Marks arrived in Australia in his early twenties and married Elizabeth Dods, a widow with three boys. They lived on Wickham Terrace and had four children, Alexander Hammett, Edward Oswald (Pat's father), Charles and Edris. The microscope was passed to Alexander Hammett on the death of Charles Ferdinand and then to Pat.

The piece is stored in a brown polished timber box that also serves as a base for the microscope when assembled. The microscope is attached to the lid through a circular base made of brass. Inside, the box is lined with blue velvet. The parts of the microscope are stored in special depositories. These include: 1 microscope barrel with eyepiece; 8 lenses of varying sizes; 1 stand with a mirror; 1 rounded mirror; 7 miscellaneous joints; 3 wooden slides with 4 samples each; 1 red unprepared slide; 1 piece of circular glass with backing. The microscope is gold, as are the hinges and the two hooks located either side of the box. There is one silver key with the box.

Fig. 8. A field microscope (H-46212).

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THE MARKS MOSQUITO COLLECTION: LEGACY OF A LIFE'S WORK AND RESOURCE FOR THE FUTURE

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Abstract

The collection of Australasian mosquitoes accumulated by Elizabeth N. (Pat) Marks during her career is unique and undoubtedly the best of its kind in Australia. The history, size and diversity of the collection, its incorporation into the University of Queensland Insect Collection, and its value as a future information resource are discussed.

Introduction

During her lifetime, Elizabeth N. (Pat) Marks established herself as a world-renowned medical entomologist for her groundbreaking work in the classification and identification of mosquitoes. She wrote many taxonomic papers on mosquitoes of the Australasian region and described 38 new species. One of her legacies is the major mosquito collection that she assembled. Pat was an enthusiastic collector throughout her career. She collected widely in many parts of Australia (Fig. 1), especially Queensland and the Torres Strait islands, and in a number of Pacific countries, including Fiji. Between 1958 and 1979 she made five trips to New Guinea. She collected not only adults but, perhaps more importantly, thousands of larval specimens that were subsequently bred through to adults. Her mosquito breeding adds enormously to our knowledge of their biology and allowed recording of length of life stages and the preservation of both larval and pupal exuviae in addition to the adult. This material now comprises about 35,000 adult specimens and about 11,000 slide mounts of larval and pupal skins.

Fig. 1. Pat Marks processing her collections at camp on Hinchinbrook Island, 1984.

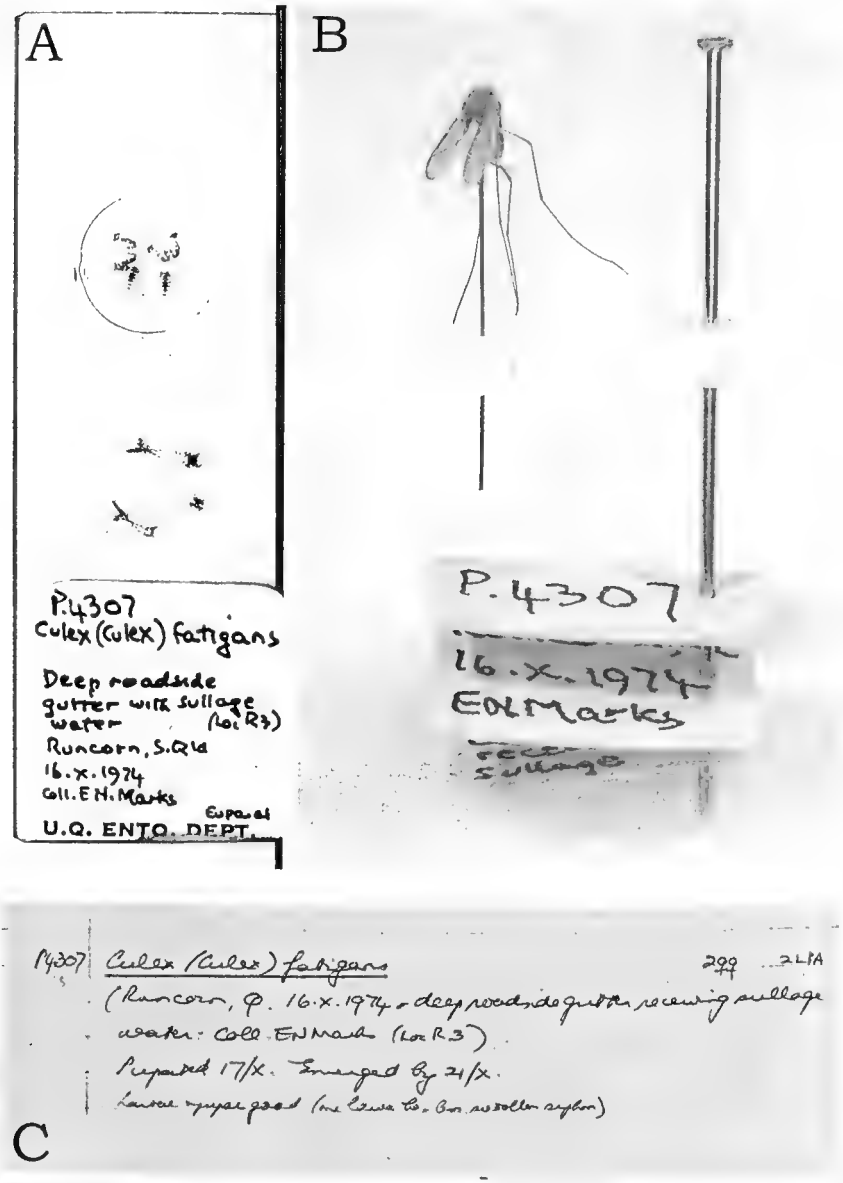


Fig. 2. Components of a link-bred specimen record for specimen P.4307 of *Culex fatigans* Wiedemann (= *C. quinquefasciatus* Say). (A) slide mount of larval and pupal skins; (B) pinned adult; (C) catalogue entry.

Figure 1 shows Pat during a collecting trip to Hinchinbrook Island, surrounded by typical untidiness and apparent chaos. However, in no way was untidiness reflected in the way she maintained records of her collections. Pat had a characteristic way of recording collection data, giving each individual specimen a code recorded in a field notebook. The same code number was allocated to each life stage so that all stages could be linked once material was stored (Fig. 2). The field notebooks contain an explanation of the code with locality and date and whatever other relevant data was available, for example, type of pond or stream, time of day, surrounding vegetation (Fig. 3). Thus the field notebooks add greatly to the value of the collected material.

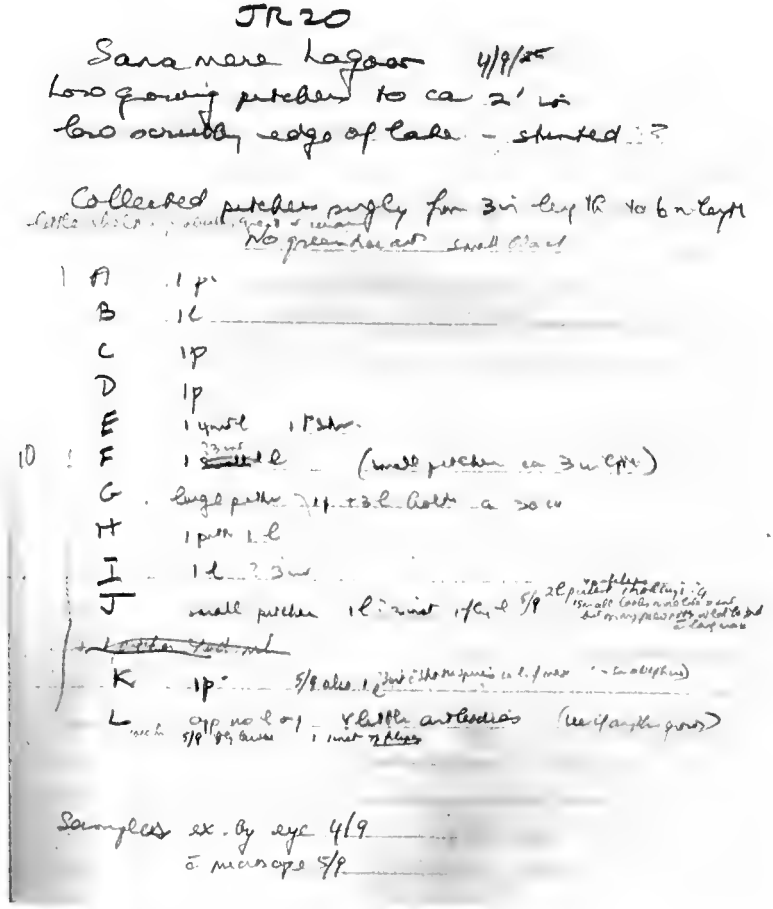


Fig. 3. Field notebook entry for specimens coded JR20.

In addition to the field notebooks, Pat created a set of catalogues. These are a neater, condensed, laboratory version of the rough field notes and also record the code number for each specimen. The first catalogue entries, for mosquitoes collected in 1943, are shown in Fig. 4.

Pat's commitment to collecting and work with the collection did not stop with her retirement in 1983 and she continued her research at the Queensland Institute of Medical Research for many years.

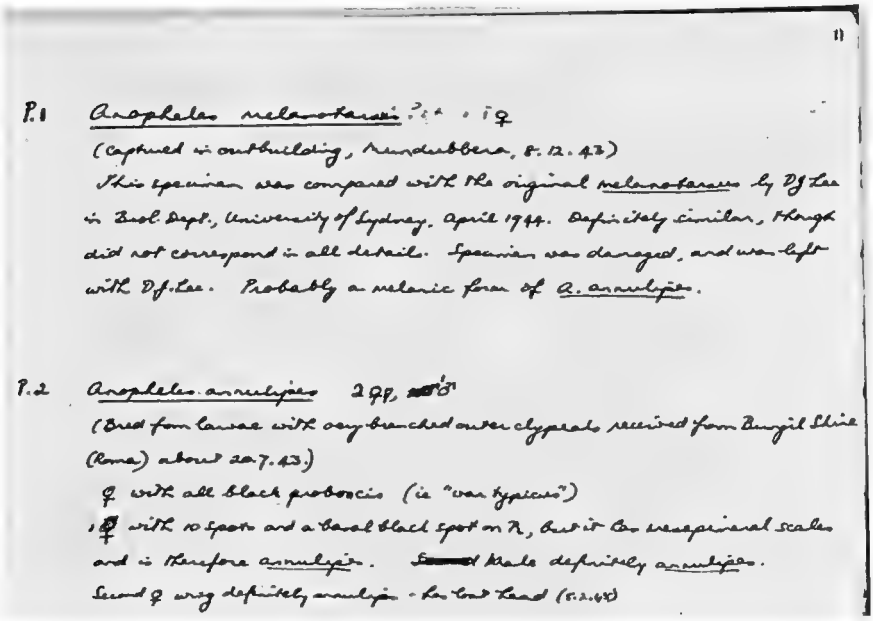
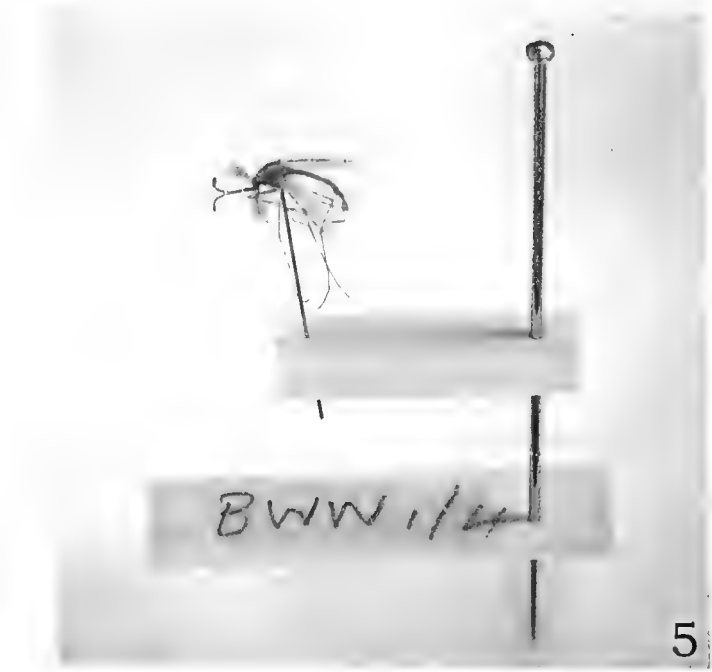
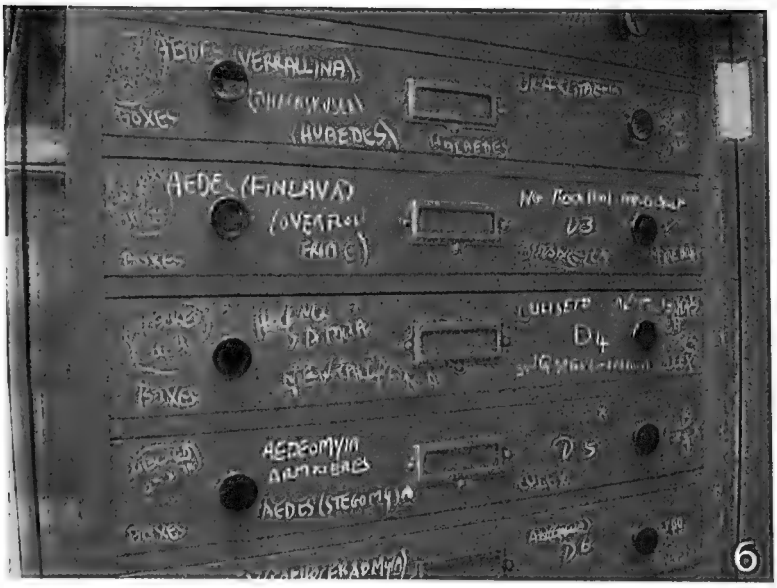


Fig. 4. The first two entries in the Marks specimen catalogue.

Incorporation into the University of Queensland Insect Collection

In 1994, at Pat's request, the bulk of the collection was incorporated into the University of Queensland Insect Collection (UQIC). Its mosquito collection was already one of the best in Australia, having received a large proportion of the mosquitoes from the School of Public Health and Tropical Medicine in Sydney when that institution was closed. The UQIC was thus the most appropriate collection to receive the Marks collection, being Queensland-based and already a centre for significant mosquito research. The collection arrived at the UQIC in a disorganized state. The pinned material was in an assortment of cabinets and boxes, and the 11,000 slides were in nine cabinets. However, most of the material was not curated. Most specimens had only a code number label (Fig. 5) and much of the identification of the pinned specimens was only indicated on the outside of the cabinets (Fig. 6).





Figs 5-6. (5) Adult specimen with only a code label. (6) Insect cabinet drawers with identifications on the outside.

For a year or so after 1994, Pat visited the UQIC irregularly to work on the collection. However, it became clear that she needed help to get the collection into a state that would allow its worth to be fully realised and made accessible to other researchers. Pat agreed, and in 1996-97 she donated $35,000 to the UQIC to fund a position for a year for a graduate research assistant, Jodie Cheesman, whose duties included: incorporating the Marks collection into the UQIC mosquito collection; updating nomenclature for each species and relabelling unit trays; identification, labelling and re-pinning of specimens; cross-referencing slide-mounted and pinned material; entering label data and names into a computer database.

Fig. 7. Pat Marks and Jodie Cheesman viewing part of the curated mosquito collection.

During the year, Jodie managed to fully curate and database about 35,000 adult pinned specimens. Pat and Jodie worked well together and Pat took great pleasure in seeing the collection transformed into a world-class taxonomic research facility (Fig. 7).

To date, the slide collection has been sorted but has not otherwise been curated nor databased. This is a great pity because, as long as it remains in its present state, we cannot easily know what material is in the collection. Many slides, like the adults, bear just the field code. Much of the collection's value lies in the many link-reared specimens - that is, the slide-mounted larval and pupal skins associated with their pinned adult (Fig. 2). If the slide collection was databased, these associations could be identified readily. Another remaining problem concerns the many specimens still on loan from other institutions. Some are easily identifiable and are in separate store boxes but all of the loan material needs to be removed and returned, a very time-consuming and expensive task.

The E.N. Marks contribution continues

Making the entire mosquito collection accessible to the wider community is an on-going objective of the UQIC. A list of all mosquito species in the UQIC is available on the Internet and can found at the UQ School of Integrative Biology's web site: *http://www.sib.uq.edu.au/insect-catalogue* under Diptera. This list allows external researchers to know what species are held and assists in requests for loans. Databasing continues and, to date, approximately 45,000 adult specimens have been databased. At present this database is available on-line to a limited number of researchers throughout Australia. The data are being used for quarantine and biosecurity purposes and specimens are being used to compare with quarantine interceptions.

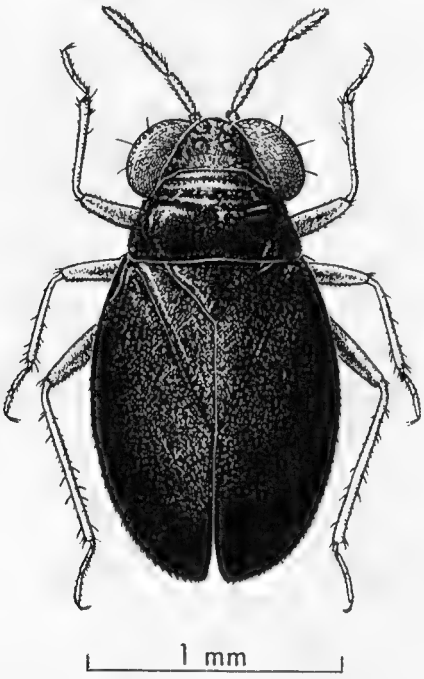
The Internet has opened up a number of ways to enhance the value of museum collections as information resources. For example, with the assistance of funds from Queensland Health, a web site about mosquito vectors of arboviruses has been developed using the UQIC material. This site can be viewed at *http://www.sib.uq.edu.au/index.html?page=32975*. It gives detailed information about the nine major vectors of arboviruses and 25 of the more common species in Queensland, plus others that could have vector potential. High quality photographs of the adults of each species can assist identification by comparison. In addition, based on UQIC specimen data, a distribution map, graphs of seasonality and biting times, and information about habitat, behaviour, vector ecology and bite prevention for each species can be studied. Much of this information is from the meticulous details recorded by Pat in her field notebooks. Another link takes the viewer to a table of mosquitoes and their associated arboviruses in Queensland.

UQ researchers have used the mosquito collection to develop computer-based interactive identification keys to Australian mosquitoes. As a result of these keys and the mosquito database, the collection has now become a valuable

resource for quarantine officers needing to identify and determine the distributions of mosquitoes that may pose a threat to human health. Medical entomology as a discipline continues to this day at UQ, with ongoing research projects focused on the mosquito vectors of malaria and dengue fever, and the development of novel approaches to control the diseases they transmit. The collection continues to contribute to this research.

Conclusion

Pat Marks was a dedicated and inspiring collector and researcher who, throughout her life, made major contributions to mosquito taxonomy, medical entomology and natural history. Information about the material she collected, and which is now incorporated into the UQIC, can be accessed via an online catalogue, specimen database and web pages about vectors of arboviruses. The collection is her legacy to future generations and she will continue to be remembered as an exceptional field collector of mosquitoes.



Corallocoris marksae (Woodward) (Hemiptera: Omaniidae), a bug collected by E.N. Marks beneath intertidal coral slabs on the Great Barrier Reef and named after her. Figure by Sybil Curtis, from CSIRO *Insects of Australia*.

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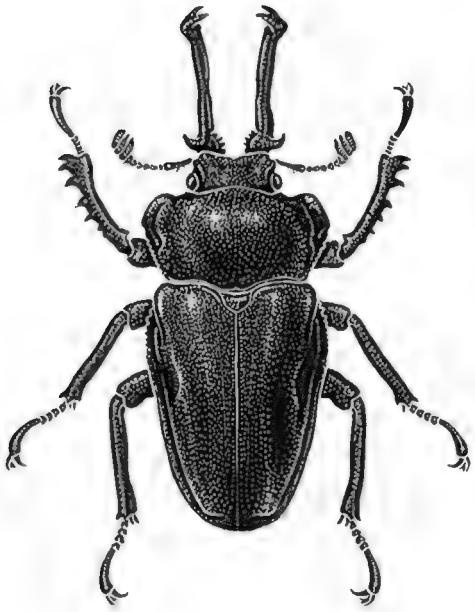

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